CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

AMENDMENTS TO THE WATER QUALITY CONTROL PLAN FOR THE SACRAMENTO RIVER AND SAN JOAQUIN RIVER BASINS

FOR

THE CONTROL PROGRAM FOR FACTORS CONTRIBUTING TO THE DISSOLVED OXYGEN IMPAIRMENT IN THE STOCKTON DEEP WATER SHIP CHANNEL

DRAFT FINAL STAFF REPORT
Appendix B
PEER REVIEW COMMENTS AND RESPONSES

24 May 2004

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Description of Peer Review Process

Health and Safety Code § 57004 requires the Regional Board to have the scientific portions of its Basin Plan Amendments undergo external peer review. The State Water Resources Control Board has a contract with the University of California to conduct the peer review.

The Regional Board followed the "Guidelines for Obtaining External Scientific Peer Review" (Pettit, 1998) issued by the State Board's Executive Director. The following provides a summary of the peer review process used for this Basin Plan Amendment:

On 9 October 2003, Regional Board staff sent a memo to the State Board's peer review coordinator requesting peer review for the proposed Basin Plan Amendment (Gowdy 2003). The memo included general background on the problem and the scientific issues that are addressed by the proposed Basin Plan Amendment. The specific questions to be asked of the peer reviewers were also provided.

On 9 December 2003, the State Board's peer review coordinator provided Regional Board staff with the names of the two peer reviewers who had agreed to perform the peer review (Bowes, 2003). The peer reviewers are: Dr. Mark Stacey an Assistant Professor in the Department of Civil and Environmental Engineering at the University of California, Berkeley and; Dr. Slawomir W. Hermanowicz, an Associate Professor in the Department of Civil and Environmental Engineering at the University of California, Berkeley.

On 30 January 2004, Regional Board staff contacted the peer reviewers and asked if they had participated in the development of the scientific basis for the proposed action, and whether they had an economic conflict of interest with regard to the outcome of their comments or recommendations (Gowdy, 2004a). Dr. Stacey (Stacey, 2004a) and Dr. Hermanowicz (Hermanowicz, 2004a) responded that they had not participated in the development of the proposed action nor had an economic interest in the outcome.

On 22 March 2004, Regional Board staff sent the peer reviewers a copy of the Staff Report and supporting Attachment A, Steering Committee Plan (Gowdy, 2004b). Peer review comments were received from Dr. Stacey on 11 May 2004 (Stacey, 2004b) and from Dr. Hermanowicz on 12 May 2004 (Hermanowicz, 2004b).

Questions for Peer Reviewers

Staff requested input on whether the peer-reviewers thought the following components of the report were adequately based on valid and reasonable interpretations of available published studies and general scientific principals:

- Identification of main factors and the mechanisms by which they contribute to the impairment
- Determination of the loading capacity as a function of flow and temperature
- Determination of the margin of safety
- Apportioning of oxygen demand loading capacity (less margin of safety) equally between the load-related and two non-load related contributing factors
- Allocation of oxygen demand loading capacity to various point and non-point sources of oxygen demanding substances (30%/70%)
- Implementation plan for continued study of causes in lieu of developing detailed wasteload and load allocations based on existing science.

Peer Review Comments and Responses

Following are numbered comments provided by each peer reviewer followed by staff responses.

Peer Review #1

Dr. Mark Stacey
Department of Civil and Environmental Engineering
UC Berkeley

May 12, 2004

Comments on March 2004 Peer Review Draft of the Dissolved Oxygen TMDL Basin Plan Amendment Staff Report.

Comment #1.1

It seems that the primary data set to establish the magnitude and frequency of the DO depletion problem is the DWR monitoring station at the northern end of Rough & Ready Island. This data set provides an integrated measure of DO in the top 17 feet of the water column, at a single location along the axis of the DWSC. It is not clear from the presentation whether or not this measure of DO is the appropriate one for comparison with the water quality objective. In particular, the lower 17-18 feet of the water column (not sampled) could be important due to the likelihood of more frequent and larger magnitude DO depletion events. It would be useful to clarify the objective in this discussion (whether it is based on a depth-averaged concentration or not, for example).

Response:
Strictly interpreted, the Basin Plan DO water quality objectives are applicable at all times and locations in the water column. The text in Section 4.2 of the staff report will be modified to clarify this point. Regional Board staff is open to considering whether modification to the DO objectives is appropriate as part of a subsequent Basin Plan Amendment.

Staff concurs with the reviewer's concern about how representative the measurements at the DWR monitoring station are of DO conditions in the lower portion of the water column. The Regional Board will be paying close attention to how future DO measurements are taken and how modeling and other analyses address the vertical distribution of mechanisms that affect dissolved oxygen concentrations. Monitoring of DO conditions will be conducted as part of the aeration demonstration project.

Comment #1.2

I would also like to emphasize the point that the authors make regarding the shift of low DO concentrations downstream by high flows in the San Joaquin River (middle of p.22). The fact that much of the discussion – particularly figure 4.3 – is based on point measurements means that the effects of flow on the DO depletion problem in the DWSC as a whole is likely to be overstated. That is, high flows do not necessarily eliminate the DO depletion problem, but rather shifts the problem away from the monitoring location.

Response:
Staff concurs with the comment that flow shifts the profile of the DO sag profile downstream. Discussion at the end of Section 4.1.1 acknowledges this shift and refers to a more detailed discussion in the *Strawman Source and Linkage Analysis for Low Dissolved Oxygen in the Stockton Deep Water Ship Channel*. pgs. 9-15. It appears that at higher flows, the sag profile is shifted into a portion of the DWSC that begins to receive inputs of Sacramento River water and is better able to assimilate oxygen demanding substances. Regardless of what happens to the oxygen demand at higher flows, the net effect for the DWSC in the vicinity of Rough & Ready Island is that DO conditions improve at higher flow rates.

Comment #1.3

Finally, tidal dispersion in the system is not discussed. Energetic oscillatory tidal flows exchange waters between the DWSC and the adjoining waters both upstream and downstream with each tidal cycle (12.4 hours). At a minimum, the tidally-driven exchange of oxygenated water into and out of the DWSC will result in the dispersion of dissolved oxygen into the DWSC and is likely to be an important re-aeration mechanism.

Response:
Staff concurs with this comment. Consideration of tidal effects on re-aeration mechanisms is an important part of DWSC modeling efforts currently contracted for and managed by the California Bay Delta Authority and will need to be assessed in subsequent revisions of this TMDL, when modeling studies are completed.

Comment #1.4

The loading capacity formulation ($LC_T = [DO_{sat}-DO_{obj}]*Q_{DWSC}$) is essentially saying that the available oxygen is entirely determined by advection from the San Joaquin River upstream, and neglects re-aeration. It should be noted that re-aeration is not limited to just vertical exchange with the atmosphere; tidal motions will disperse oxygenated waters into the DWSC from both upstream and downstream and for the purposes of this analysis could be considered as a re-aeration. Further, and perhaps more importantly, this formulation does not include any consideration of the rate of consumption of oxygen in the DWSC, or the residence time of waters in the DWSC. These factors are the ones that have been altered by changes in the geometry of the DWSC and the diversion of San Joaquin River flows. That fact that the DO concentration profiles follow a sag profile through the DWSC (end of section 4.1.1, p.22) indicates that these rates are significant and that re-aeration and depletion rates should be identified and acknowledged in the loading capacity.

Response:
Staff acknowledges the need to clarify the definition of loading capacity with regard to re-aeration and depletion rates. The definition of loading capacity was intended to apply to the net oxygen demand of all mechanisms that add or deplete oxygen to the water column. Clarification of the definition of loading capacity is provided in the revised draft of the staff report.

Staff also acknowledges that the actual mechanisms and variables affecting the DO concentration profile in the DWSC are more numerous and complex than represented in Equation 4-1. The intent of the equation is to establish a starting point for the allocation of loading capacity, and ultimately, responsibility for mitigating the effect of the various factors contributing to the impairment. A more detailed representation of the numerous mechanisms and variables is being undertaken as part of a larger modeling effort being funded and managed by the California Bay Delta Authority. The results of this modeling will be used in a subsequent revision to this TMDL to develop a more detailed allocation of loading capacity and responsibility for solving the impairment.

Comment #1.5

Because the formulation of the loading capacity as presented neglects the re-aeration and depletion rates, it is quite difficult to evaluate whether the margin of safety is appropriate. Due to the neglect of re-aeration, and essentially assuming an infinite residence time (such that the oxygen demand is fully realized), the loading capacity as formulated is likely to be overly conservative.

Response:
Comment noted. See responses to previous comment regarding consideration of re-aeration mechanisms.

Comment #1.6

I agree with the authors' determination that upstream loading, changes to the geometry of the DWSC and the reduction of San Joaquin River flows have all contributed to the depletion of DO in the region. The equal division of the calculated loading capacity into three equal parts, however, does not seem to be justified. The use of a linear decomposition between the three factors ignores the multiplicative effects that are inherent in the processes as described. As acknowledged in the discussion, the altered geometry would not be a problem if there were no loading from upstream. This is due to the fact that the dredging of the DWSC has magnified the rate of consumption of oxygen and increased the residence time in the DWSC so that the loading from upstream can have a more deleterious effect on the system. Linearly allocating the 'loading' to the three primary factors obscures these non-linear interactions.

Response:
As stated in the response to Comment #1.4, staff acknowledges that the actual mechanisms and variables affecting the DO concentration profile in the DWSC are more numerous and complex than represented by the loading capacity equation in the staff report. The intent of the equation is to establish a starting point for the allocation of loading capacity, and ultimately, responsibility for mitigating the effect of the various factors contributing to the impairment. A more detailed representation of the numerous mechanisms and variables is being undertaken as part of a larger modeling effort being funded and managed by the California Bay Delta Authority. The results of this modeling will be used in a subsequent revision to this TMDL to develop a more detailed allocation of loading capacity and responsibility for solving the impairment.

Comment #1.7

As an alternative, the limit for loading from upstream could be calculated based on the sag profile that has been validated for the system. This solution would define the upstream loading capacity (LC) as a function of the volume of the DWSC, the net flow through the DWSC, and the rate of oxygen consumption in the DWSC. As such, this limit on the upstream loading would be determined by the geometry of the DWSC and the net flow through the DWSC, and the effects of re-aeration by tidal dispersion into the DWSC could be accounted for. To meet the requirements for DO in the DWSC, therefore, several strategies could be pursued: decreasing upstream loading, reducing the rate of oxygen depletion in the DWSC, providing additional oxygen supply (aeration), or a combination of these. Allocation of the financial responsibility to meet these requirements in equal parts between the parties responsible for the three primary factors would then be appropriate. Formulating the loading capacity in this way – such that the limit is based on factors that are determined by the DWSC geometry and flow – will allow for strategies that trade-off mitigations upstream and within the DWSC.

Response:
The suggested allocation approach does not appear to provide another means of reallocating the share of responsibility, only that once allocated, an alternate method could be used to determine loading capacity of oxygen demanding substances. The staff report is based on a technical assessment of the causative factors, combined with an

assessment of equitability, likelihood of success, and flexibility and already suggests a reasonable method that achieves the same advantages stated for the proposed alternative approach.

In addition, two important problems exist with use of the proposed approach for determining limits for upstream loading at this time. First there is not a sag profile that has been validated for the system. Modeling studies and data collection are underway that could potentially provide such validation in approximately two years. Secondly, staff are not aware of measurements or estimates of re-aeration by tidal dispersion in the DWSC that have been validated at this time.

After the completion of the upcoming studies, the allocation approach may be revisited as part of a revision to this TMDL. Further consideration of alternate approaches to the allocation approach may be considered at that time. Also, more data and analysis regarding the sag profile and re-aeration rates will be available at that time.

Comment #1.8

In view of the scientific uncertainties described above, and due to the fact that research on the DWSC is currently being pursued and will be continued into the future, I would strongly encourage the pursuit of a phased approach.

<u>Response:</u>
Comment noted.

Peer Review #2

Dr. Slawomir W. Hermanowicz
Department of Civil and Environmental Engineering
UC Berkeley

May 12, 2004

Evaluation of the “Dissolved Oxygen TMDL Basin Plan Amendment Staff Report”

Comment #2.1

Although none of the three factors listed in the *Staff Report* is singularly responsible for oxygen deficiency, the **combination** of oxygen-consuming loads and low net velocity in the channel is responsible for the problem. In turn, the velocity is a direct function of channel geometry and water flow upstream of the channel.

<u>Response:</u>
Comment noted.

Comment #2.2

From a **scientific** point of view, the development of the loading capacity in the form presented by Eq. 4-1 would make sense if dissolved oxygen was a conservative substance entering the DWSC. However, dissolved oxygen is consumed by microbial processes, generated by algae, transferred from the atmosphere, and imported and exported with the flow. Low DO concentration in the channel is a result of an imbalance between the **overall rate** of oxygen consumption and export, and the **rate** of oxygen supply and generation. In this sense, the verbal definition on p. 34 as the *"allowable rate of oxygen deman*d" is much better.

<u>Response:</u>
Staff concurs with the comment that the DO concentration in the DWSC is the result of the net effect of the rate of oxygen consumption and export and the rate of oxygen supply and generation. The definition of loading capacity provided in the staff report was intended to apply to the net oxygen demand of all mechanisms that add or deplete oxygen to the water column. To avoid confusion, the definition of loading capacity with regard to re-aeration and depletion rates, has been clarified in Section 4.4.1.

Comment #2.3

Although both the **rates** of oxygen consumption, generation and supply are expressed in the same units (lb/day) as the proposed loading capacity, they are not equivalent. The rates describe intensities of specific physical, chemical and biological processes while the proposed loading capacity is an abstract construct. This limitation of the loading capacity and the TMDL developed on its basis was acknowledged on p. 41 of the *Staff Report* where it stated that due to this deficiency *"detailed load limitations or requirements for other mitigation measures are not possible at this time."* It appears that the loading capacity and the TMDL were developed as a tool to allocate responsibility for DO depletion to various parties, and in this context the abstract construct may serve its purpose.

The loading capacity expressed by Eq. 4-1 is essentially proportional to the net flow rate and although expressed in the units of lb/day, it is a regulatory tool rather than a physically meaningful quantity.

<u>Response:</u>
Comment noted. As discussed in the response to the previous comment, the definition of loading capacity in the staff report has been clarified so it is understood to address the net oxygen demand of all mechanisms that add or deplete oxygen to the water column. In addition, staff acknowledges that the actual mechanisms and variables affecting the DO concentration profile in the DWSC are more numerous and complex than represented in Equation 4-1. The intent of the equation is to establish a fundamental starting point for the allocation of loading capacity and ultimately responsibility for mitigating the effect of the various factors contributing to the impairment. A more detailed representation of the numerous mechanisms and variables is being undertaken as part of a larger modeling effort being funded and managed by the California Bay Delta Authority. The results of

this modeling will be used in a subsequent revision to this TMDL to develop a more detailed allocation of loading capacity and responsibility for solving the impairment.

Comment #2.4

The proposed MOS value of 40% is composed of two parts. The first part of 20% is based on *"professional judgement"* and, while it may be appropriate, it was not scientifically tested or validated. The second part, also of 20%, seems to overestimate flow inaccuracies at higher flows; it should be expressed as a fixed value related to the stated inaccuracies of velocity measurements.

<u>Response:</u>
Although the 20% estimate was based on applying a fixed estimate of accuracy to low flow rates, the resulting overestimate of error at higher flows is offset by the fact that no estimate of accuracy has been developed for the UVM station, which is the primary source for net flow data in the DWSC. As discussed in *Issues in Developing the San Joaquin River Deep Water Ship Channel DO TMDL (Lee and Jones-Lee, 2000, pg. 26),* the estimates of accuracy upon which the margin of safety were based came from a similar instrument that is installed on Three Mile Slough in the western Delta. Further studies of the accuracy of the Stockton UVM will be performed as part of the studies of the phased implementation plan.

The 20% margin of safety attributed to best professional judgment is needed to account for the uncertainty about the specific mechanisms by which causative factors are linked to the impairment. Many of the causative factors have been identified based on empirical observations. A better quantified understanding of the linkage mechanisms is needed.

A revised margin of safety will be scientifically validated based on the findings of the studies to be conducted as part of the program of implementation.

Comment #2.5

While the allocation of the load-related TMDL portion (one-third of the total) between Stockton and upstream sources can be justified scientifically (see Section 5 of my report), no such justification can be provided for the primary equal allocation between load, channel geometry, and reduced flows. As stated in Conclusion #1, the combination of all three factors is responsible for DO depletion in the DWSC, there is no **scientific** basis for equal allocation of TMDL. Such allocation, or another split, may be justified in social or political terms if all three factors are recognized as controllable within the meaning of the CVRWQCB Controllable Factors Policy. This assessment was recognized in the *Staff Report* (p. 2 and 9) where the primary TMDL allocation is based on *"equitability*". This criterion was further emphasized in Section 5 of the *Staff Repor*t. Similarly, the *Draft Strawman Source and Linkage Analysis* (April 2002) explicitly linked the benefits of the DWSC *"presence"* and the *"removal and use of San Joaquin River water"* to the responsibility for low DO conditions.

The allocation (in the) TMDL **equally** to three contributing factors may be justified on *"equitability"* or other social, political or economic basis. Scientific method cannot be applied to arrive at such precise quantitative division.

Response:
Comment noted.

Comment #2.6

Within available scientific knowledge, the allocation of a load-related TMDL portion between Stockton RWCF (30%) and to sources of algae and/or precursors in the watershed (70%) is generally consistent with available data.

Response:
Comment noted.

Comment #2.7

Scientifically irreducible uncertainty of any ultimate decision regarding DWSC will remain significant. For this reason, further "source and linkage" studies will contribute marginally to the establishment of TMDL. Such studies and those of possible remediation measures may have a value once the basic TMDL decision is made to find cost-effective, equitable and feasible solutions of oxygen depletion in the DWSC.

Response:
Comment noted.

Health and Safety Code § 57004

57004. (a) For purposes of this section, the following terms have the following meanings:
(1) "Rule" means either of the following:
(A) A regulation, as defined in Section 11342.600 of the Government **Code**.
(B) A policy adopted by the State Water Resources Control Board pursuant to the Porter-Cologne Water Quality Control Act (Division 7 (commencing with Section 13000) of the Water **Code**) that has the effect of a regulation and that is adopted in order to implement or make effective a statute.
(2) "Scientific basis" and "scientific portions" mean those foundations of a rule that are premised upon, or derived from, empirical data or other scientific findings, conclusions, or assumptions establishing a regulatory level, standard, or other requirement for the protection of public health or the environment.
(b) The agency, or a board, department, or office within the agency, shall enter into an agreement with the National Academy of Sciences, the University of California, the California State University, or any similar scientific institution of higher learning, any combination of those entities, or with a scientist or group of scientists of comparable stature and qualifications that is recommended by the President of the University of California, to conduct an external scientific peer review of the scientific basis for any rule proposed for adoption by any board, department, or office within the agency. The scientific basis or scientific portion of a rule adopted pursuant to Chapter 6.6 (commencing with Section 25249.5) of Division 20 or Chapter 3.5 (commencing with Section 39650) of Division 26 shall be deemed to have complied with this section if it complies with the peer review processes established pursuant to these statutes.
(c) No person may serve as an external scientific peer reviewer for the scientific portion of a rule if that person participated in the development of the scientific basis or scientific portion of the rule.
(d) No board, department, or office within the agency shall take any action to adopt the final version of a rule unless all of the following conditions are met:
(1) The board, department, or office submits the scientific portions of the proposed rule, along with a statement of the scientific findings, conclusions, and assumptions on which the scientific portions of the proposed rule are based and the supporting scientific data, studies, and other appropriate materials, to the external scientific peer review entity for its evaluation.
(2) The external scientific peer review entity, within the timeframe agreed upon by the board, department, or office and the external scientific peer review entity, prepares a written report that contains an evaluation of the scientific basis of the proposed rule. If the external scientific peer review entity finds that the board, department, or office has failed to demonstrate that the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices, the report shall state that finding, and the reasons explaining the finding, within the agreed-upon timeframe. The board, department, or office may accept the finding of the external scientific peer review entity, in whole, or in part, and may revise the scientific portions of the proposed rule accordingly. If the board, department, or office disagrees with any aspect of the finding

of the external scientific peer review entity, it shall explain, and include as part of the rulemaking record, its basis for arriving at such a determination in the adoption of the final rule, including the reasons why it has determined that the scientific portions of the proposed rule are based on sound scientific knowledge, methods, and practices.
(e) The requirements of this section do not apply to any emergency regulation adopted pursuant to subdivision (b) of Section 11346.1 of the Government Code.
(f) Nothing in this section shall be interpreted to, in any way, limit the authority of a board, department, or office within the agency to adopt a rule pursuant to the requirements of the statute that authorizes or requires the adoption of the rule.

References

Bowes, G.W. 2003. Revision: Peer Reviewers Draft Basin Plan Amendment Staff Report for the Low Dissolved Oxygen Total Maximum Daily Load (TMDL) for the San Joaquin River. Memo from Gerald W. Bowes, State Water Resources Control Board, to Mark Gowdy, California Regional Water Quality Control Board, Central Valley Region. 9 December 2003.

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